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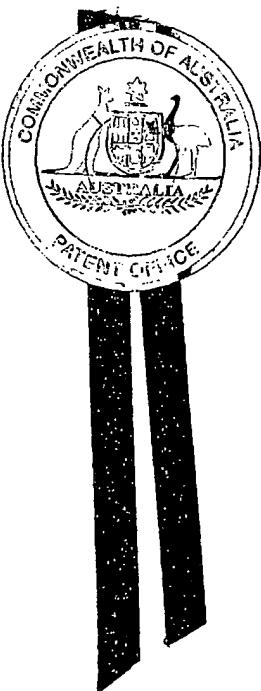
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I, JANENE PEISKER, TEAM LEADER EXAMINATION SUPPORT AND SALES hereby certify that annexed is a true copy of the Provisional specification in connection with Application No. 2004901815 for a patent by SHINAGAWA REFRactories AUSTRALASIA PTY LTD. as filed on 05 April 2004.

WITNESS my hand this
Eleventh day of April 2005

JANENE PEISKER
TEAM LEADER EXAMINATION
SUPPORT AND SALES



Refractory Installation Method And Apparatus

Field of the invention

[0001] The present invention relates to installation systems and devices for applying and forming settable slurries such as refractory linings, insulation, concrete, cement and similar products.

Background Of The Invention

[0002] Conventional methods of application of refractory linings to furnace walls by gunning techniques result in a relatively large amount of product which contacts the target area and rebounds therefrom. This rebounded refractory material or slurry can deposit itself into the recently sprayed portion or onto the furnace floor. This rebound can comprise up to 10% to 15% of the effective or useful product actually sprayed onto the furnace surface. This 10% to 15% represents a relatively large amount of wastage and at the cost of is valuable and thus desirable.

Summary Of The Invention

[0003] The present invention provides a slurry spraying or installation system including a gun means, a spray nozzle and a conduit connecting said gun means to said spray nozzle, said gun means including a pump means to move dry particulate towards said nozzle along said conduit, wherein between said gun means and said nozzle is a mixing device which receives said dry particulate and mixes same with liquid under a greater pressure than the pressure that said dry particulate is under, so as to form a liquid and dry particulate mixture; said mixture being fed to said nozzle for dispensing to a target.

[0004] The mixing device can include an expansion chamber having a diverging passage which diverges in the direction of flow of said dry particulate.

[0005] The mixing device can include, downstream of said diverging passage, a transition passage which has a substantially constant cross section.

[0006] At least one of said diverging passage or said transition passage, or at a location between these passages, there can be included a liquid inlet.

[0007] The liquid inlet can include a liquid inlet nozzle which projects liquid from said nozzle at an angle to the direction of flow of said dry particulate through said mixing device. The liquid inlet nozzle can be at an angle of between 40° and 80° from the direction of flow.

[0008] The nozzle can be aligned so that a central longitudinal axis thereof intersects a central longitudinal axis of said mixing device. Alternatively the nozzle can be aligned so that a central longitudinal axis thereof is skewed relative to a central longitudinal axis of said mixing device.

[0009] The mixing device can include a converging passage downstream of said transition passage.

[0010] Preferably the inlet to the diverging passage has is of a larger cross sectional area than the cross sectional area of the end of the conduit delivering said dry particulate from said gun means to said mixing device.

[0011] The inlet to the diverging passage can have a diameter in the range from 5% to 200% larger than the internal diameter of the conduit delivering dry particulate to said diverging passage. Preferably, the conduit has an internal diameter of approximately 38mm and said inlet diameter of said diverging passage is in the range of 40 to 60mm and possibly up to 80mm.

[0012] Preferably, the inside diameter of said diverging passage at the end of said passage is of the order of 55 mm to 80 mm. A preferred set of dimensions include: the inlet is 50mm and the end of the passage expands out to 65mm for a 38mm inside diameter conduit delivering dry particulate to said diverging passage.

[0013] The diverging passage can be of a length which varies from 150 to 900mm.

[0014] The transition passage can have the same cross sectional area or internal diameter as the outlet end of the diverging passage. Preferably, the transition passage extends for a distance of between 100 and 300mm.

[0015] The converging passage can terminate in an outlet passage of substantially constant cross section. The outlet can have a cross sectional area which is approximately equal to the cross sectional area of the passage in a conduit to be connected to said outlet. The outlet can have an internal diameter which is approximately equal to the internal diameter of a conduit to be connected to said outlet.

[0016] The converging passage can vary between of the order of 60mm to 80mm at its larger diameter and tapers down to 38mm on its outlet diameter. The length of the taper can vary between 350mm and 1500mm. The length of taper or converging can be of the order of 600mm to 800mm but most preferably around 720mm.

[0017] The diverging portion can end in an outlet passage which is of substantially constant cross section which can extend for between 80mm and 200mm and more preferably 120mm.

[0018] The liquid inlet can be a liquid ring, however, most preferably, for the purposes of refractory and or concrete systems the liquid inlet is a nozzle. The nozzles preferred are those manufactured by Spray Systems Company Pty Ltd, as detailed below.

[0019] In respect of a system whereby the gun means the nozzle during use and the mixing device are within a height differential of between up to 1 metre to 2 metres of each other, the mixing device is to be located along a conduit length of no more than 90 metres from the nozzle. The mixing device can be in the range of 5 m to 15 m from the gun means. Illustrated in figure 10 is a schematic showing the expected height and conduit length limitations. These limitations will be described in more detail below.

[0020] The gun means preferably applies a pressure of between 100kPa and 600kPa to the dry particulate.

[0021] The liquid inlet to the mixing device can have its own supply and pressure source.

[0022] The pressure source can supply liquid to the liquid inlet at approximately 1000kpa. Alternatively, the pressure source can supply enough pressure to provide a pressure differential between the liquid inlet pressure and the dry particulate pressure of the order of 200kpa to 900kpa.

[0023] Preferably the liquid inlet nozzle propels liquid in a spray stream, wherein the range of spray angle for the jet emitted therefrom is of the order of 70° to 120° with a flow rate of between 1 US gallon per minute to 4 US gallons per minute.

[0024] Preferably the system develops a pressure of the order of 100kPa to 200kPa, when measured at approximately 1 metre to 2 metres back from the nozzle.

[0025] Preferably said system includes the ability to add liquid to said slurry at said nozzle prior to ejection or emission from said nozzle.

[0026] Present invention also provides a mixing device to preform a settable slurry, said device including an inlet having a larger internal cross sectional area than a hose connected to said device to deliver to said device a dry particulate under pressure to be preformed into said slurry, a diverging passage extending from said inlet and a transition passage located downstream of said diverging passage, said transition passage having a substantially constant

cross section, and a liquid inlet being located in one said diverging passage or said transition passage.

[0027] The mixing device can be formed from liners which respectively include the diverging transition and converging passages.

[0028] The inlet end of the diverging passage has a flange to allow said inlet end to connect to a hose by a coupling device.

[0029] The device can include an a converging passage whereby the outlet end of the converging passage has a flange to allow connection to a conduit by a coupling device.

[0030] The liners can be manufactured from a polymeric material. The liners can be mounted within a generally cylindrical jacket and compressed into communication with each other to carry said mixture. The liners can be manufactured from metals such as stainless steel, mild steel, brass, or polymeric materials such as urethane, nylon and others.

[0031] The mixing device can include one or more of the features described above which are attributable to a mixing device as described in paragraphs [0004] to [0025] above

Brief description of the Drawings

[0032] An embodiment of the present invention, will now be described by way of example only, with reference to the accompanying drawings in which:

[0033] Figure 1 is a schematic of the components of an installation system embodying the invention for the application of refractories by a gunning method;

[0034] Figure 2 illustrates a diverging passage liner and casing;

[0035] Figure 3 illustrates a transition passage liner and casing;

[0036] Figure 4 illustrates a converging passage liner and casing;

[0037] Figure 5 illustrates the casings of Figures 2 to 4 assembled into a mixing device;

[0038] Figure 6 illustrates a pump flow schematic diagram and

[0039] Figure 7 illustrates a mixing device similar to that of figure 5 with additional components;

[0040] Figure 8 illustrates another view of the diverging passage casing with a nozzle therein;

[0041] Figure 9 illustrates a view of the transition passage casing of figure 3 with a nozzle associated therewith;

[0042] Figure 10 illustrates a schematic showing the height and conduit length limitations on the system;

[0043] Figures 11, 12 and 13 are the specifications for the nozzles BH1/4VV-SS8003, BH1/4VV-SS11003 and BH1/4VV-SS110015 respectively; and

Detailed Description Of The Drawings

[0044] Illustrated in Figure 1 is a refractory installation system 10 for spraying a refractory liner slurry onto a furnace wall or components. The system 10 includes a gun device 12 such as the LOVA™ brand of gun manufactured by REED® having some 20 or 21 pockets or the SOVA™ brand of gun, also manufactured by REED® having an 16 pocket feed wheel, however other rotary guns are suitable.

[0045] The gun 12 has a gun hopper 14 into which a dry particulate material which will form the slurry can be fed. In the following description the dry particulate material will be for use as a refractory lining, but it will be appreciated that other dry particulate such as cement or other appropriate material can be used.

[0046] The dry particulate material is fed by the gun 12 into a feed conduit 16 so as to be delivered to a preform mixer 20 where the dry particulate is mixed with a liquid from a pump 22. The liquid can include such things as water, aqueous solutions such as those including a surfactant or colloidal silica solutions or a solution having a setting accelerator for the slurry. The pump 22 delivers the liquid under pressure to the preform mixer 20 so as to form a "slurry preform", which may also be described as a product preform. At this stage, the product preform cannot be described as a "slurry" *per se* as there is in the product preform more dry particulate than liquid.

[0047] The product preform being a mixture of the liquid and dry particulate, allows the product preform to begin the setting process. However, the final liquid content of the slurry to be ejected from the nozzle 17 is achieved or determined by the amount of water or other liquid added to the product preform at the nozzle 17.

[0048] Thus the product preform mixture exits the mixing device 20 where it progresses along a second feed conduit 18 to a standard delivery nozzle 17. At the nozzle 17, if a wet slurry is being pumped and ejected from the system 10, there is added water from a mains water supply 19 (or water or other liquid can be added from a pump) which would be ordinarily used to add the final amount of liquid to form the slurry, so that it is completely formed as it exits the nozzle 17.

[0049] Illustrated in Figures 2 to 4 are the components of the preform mixer 20 which are also shown as an assembly in Figure 5. The preform mixer 20 is made up of an inlet segment 20.1, which can be broadly described as having an expansion chamber therein; a central transition segment 20.2 which has a settling chamber therein; and an outlet segment 20.3 which can be broadly described as having a compression chamber therein. The inlet segment 20.1 is made from a liner 20.31 and a casing 20.30; the transition segment 20.2 is made from a liner 20.34 and a casing 20.35; and the outlet segment 20.3 is made from a liner 20.33 and a casing 20.36, as will be described in more detail below.

[0050] As can be seen from Figure 2, casing 20.30 of the inlet segment 20.1 has a standard REED® brand threaded hose end 20.4, so that a standard 38 mm inside diameter hose, which makes up the feed conduit 16 from the gun to the preformed mixer 20, can be connected to the inlet segment 20.1.

[0051] It will be noted that the liner 20.31 of inlet segment 20.1 has a divergent passage 20.5 which forms the expansion chamber. The passage 20.5 starts at the inlet 20.6 with an inside diameter of 50mm and diverges or tapers at a generally constant rate to the maximum diameter of 65mm at the outlet 20.7.

[0052] A 50mm inside diameter inlet 20.6 is provided to ensure that the flow of dry particulate into the inlet 20.6 slows down by the increase in cross sectional area from the hose to the inlet segment 20.1.

[0053] Near to the downstream end of the inlet segment 20.1 is an inlet nozzle 20.8 which passes through both the casing 20.30 and the liner 20.31. The nozzle 20.8 is mounted in a housing which is welded or otherwise joined to the casing 20.30. As can be seen in Figure 5 the nozzle mounting and thus the nozzle 20.8 makes an angle of approximately 75° to the longitudinal axis of the preform mixer 20 (or the direction of flow through the mixer 20). The nozzle 20.8 allows a liquid (such as water) to be injected under pressure into the dry particulate flow stream passing through the diverging passage 20.5.

[0054] The outlet or downstream end of the casing 20.30 includes a flange 20.9 which will allow the inlet segment 20.1 to be bolted to the transitional segment 20.2 by a similarly shaped flange 20.10 on the casing 20.35.

[0055] While the inside diameter 20.6 of the liner 20.31 is 50mm and is for use with respect to a 38mm hose, this inside diameter 20.6 could be of a magnitude which ranges from about 40mm (approximately 5% greater than the hose inside cross sectional area) up to approximately 80mm. Even though an increase in the cross sectional area, being indicated in the

increase from diameter 38mm of the conduit 16 up to an 80mm inside diameter for the inlet, would seem like a large increase, such a large increase will have little effect on the slowing down of the flow as secondary flows and cyclonic currents will form effectively reducing the diameter from 80mm to a smaller dimension. The length of the inlet segment 20.1 is approximately 350mm.

[0056] It will be noted from Figure 3 that the transition segment 20.2 has its liner 20.34 comprised of a cylindrical passage 20.11 passing through it. The passage 20.11 is substantially constant in cross section. the transitional segment 20.2 is of a length of approximately 150mm

[0057] The transition segment 20.2 terminates in a bolting flange 20.12 which allows for connection to the bolting flange 20.13 of the outlet segment 20.3.

[0058] Ordinarily, between the flanges 20.13 and 20.12 or 20.10 and 20.9 an annular gasket or O-ring seal would be provided. However as the liners 20.31, 20.34 and 20.33 are manufactured from urethane or other appropriate polymeric material, once the flanges 20.13, 20.12, 20.10 and 20.9 have been respectively bolted together, there the compressive forces on the respective ends of the liners form an effective seal, obviating the need for gasket or other sealing materials. However, if the liners were manufactured from metal, such seals or sealing compounds may be required.

[0059] The outlet segment 20.3, as illustrated in Figure 4 has a liner 20.33 which has a compression chamber therein formed by a converging passage 20.16 which tapers from an inlet 20.17 having an inside diameter of 65mm to a minimum of 38mm at the outlet 20.18.

[0060] It will be noted that the liner 20.33 and outlet segment 20.3 has a substantially constant cross section outlet passage 20.19 which proceeds to the terminus of the outlet segment 20.3.

[0061] The outlet segment 20.3 has its casing 20.36 terminating in a REED® brand mounting flange 20.20 for connecting, by means of a quick coupling system, to the feed conduit 18 of Figure 1.

[0062] The thickness of the liners, such as the liner 20.31 varies from a maximum at 20.32 of approximately 20mm to a lesser thickness in the region of 20.33 of approximately 10 to 12mm.

[0063] The outer cylindrical or tubular steel casings 20.30, 20.35 and 20.36, help to provide strength to the liners which might be manufactured from such materials as urethane, nylon or other appropriate polymeric material. The liner could also be manufactured from brass

or from steel or the whole inlet segment 20.1, transition segment 20.2 and outlet segment 20.3 manufactured from a single piece of metal.

[0064] The outlet passage 20.19, which is of constant cross section, on the outlet segment 20.3 extends for approximately 120mm. Whereas the tapered nature of the passage 20.16 is such that the taper occurs over a distance of approximately 720mm.

[0065] Whilst a dimension of 720mm is indicated as the length of the taper for the compression chamber formed by the passage 20.16, this length could vary from 350mm to 1500mm, depending on the application and slurry being installed.

[0066] Similarly the expansion chamber formed by the passage 20.5 has its length indicated as being approximately 350mm, however this could vary between 200 mm and 600 mm depending on the application.

[0067] The interaction of the flow of a liquid from the injection nozzle 20.8 and the flow of dry particulates passing through the diverging passage 20.5, is such that near to the end of the diverging passage 20.5 and in the passage 20.11 there are formed vortices or cyclones which aid in the mixing of the a liquid from the nozzle 20.8 with the dry particulates being forced through the mixing device 20 under pressure.

[0068] The nozzle 20.8 as mentioned in Figure 1 receives a liquid at a high pressure from the pump 22. The nozzle 20.8 is preferably of a type manufactured by Spray Systems Company Pty Ltd of Australia and they have three nozzles which are suitable for a variety of applications. Thus the following nozzles have been found to be useful in the following applications:

[0069] BH1/4VV-SS11003. This nozzle operated at 3 US gallons per minute with a spray angle of approximately 110° both at an operating pressure of 40 psi. This nozzle is suitable for low cement, standard high, gun materials;

[0070] BH1/4VV-SS110015 operated at 1.5 US gallons per minute with a spray angle of 110° both at an operating pressure of 40 psi and is suitable for conventional gun materials.

[0071] BH1/4VV-SS8003 has an 80° cone angle from the nozzle with a 3/US gallon per minute both measured at a flow rate of 40 psi. Flow rate through this nozzle was suitable for silicon carbide and any gun mixes needing more material control.

[0072] The specifications for these nozzles are included as figures 11, 12 and 13 of the attached drawings.

[0073] Whilst the above-described nozzle 20.8 passes through the casing 20.30 and is directed towards the centre line through the passage 20.5 and this does provide sufficient cyclonical vortex mixing to occur, if desired the axial direction of the nozzle 20.8 and its mounting arrangement, can be skewed relative to the central axis of the passage 20.5 to possibly provide a greater amount of vortex or cyclonic motion and thus possibly better mixing.

[0074] Illustrated in Figure 6, the pump 22, which is generally designated as such in figure 1, has a tank 22.1 which can be mounted on a support frame (not illustrated), which provides liquid to be passed into the actual pumping unit which is a displacement pump 22.3. At the bottom of the tank 20 is a liquid outlet 22.4 which is connected by a conduit 22.5 to the inlet 22.6 of the pump 22.3.

[0075] The pump 22.3 is on a stand 22.7. To enable transportation of the pump unit 22, a drain valve 22.9 is provided with a manually operated valve member 22.10 so that the tank can be emptied as desired.

[0076] A liquid filter 22.11 is also provided in the line 22.5 so that liquid from the tank 22.1 can be filtered prior to entry at the inlet 22.6 of the pump 22.3.

[0077] The pump 22 also includes a pressure tank 22.20 on an outlet line 22.21 which also include a pressure switch 22.22 and a pressure gauge 22.23. An air poppet valve 22.24 and a check valve 22.25 can also be provided on the outlet line 22.21 which directs the liquid under pressure to the nozzle 20.8 of Figures 2 and 5.

[0078] The air poppet valve 22.24 is connected with the gun 12 so that when the operator of the gun 12 starts to provide dry particulate under pressure into the conduit 16, the air poppet valve 22.24 by virtue of the increase pressure in the line 22.25 connecting the poppet valve to the gun 12, will cause the poppet valve to open thus allowing liquid to now flow along conduit 22.21 to the preform mixer 20 and out of nozzle 20.8. With the system 10, the nozzle operator works together with the gun operator to control the flow through the system.

[0079] Illustrated in Figure 7 is a preform mixing system 220 which has an inlet segment 20.1, transition segment 20.1 and outlet segment 20.3 which are the same as the corresponding units on the mixer 20 of Figures 2 to 5. However, in addition to these the mixing unit 220 also includes a pelletising chamber 220.1 and a second compression chamber 220.2 of approximately 100mm and 800mm respectively in length. The pelletising chamber can be useful in some circumstances so as to ensure complete mixing for harder to mix products such as concrete and the like.

[0080] Illustrated in Figure 8 is the expansion chamber of the inlet segment 20.1 showing the nozzle 20.8 and the spread of the spray jet coverage from that nozzle 20.8 whereby the angle α represents an angle of the spray from the nozzle 20.8 of between 80° and 100° .

[0081] Illustrated in Figure 9 is the transition segment 20.2 which can, as an alternative, include the nozzle 20.8 therein. This has been found to be effective but not as effective as when the nozzle 20.8 is mounted near the end of the expansion chamber. As the rate of flow of the dry particulate at the end of the expansion chamber is approximately the same as that in the transition segment 20.2, the end of the expansion chamber is the first opportunity to inject the liquid spray with the dry particulate travelling at its slowest.

[0082] The liners 20.33, 20.31 and 20.34 can be made from urethane or approximately 90 dent or any appropriate material – rubber, nylon, other synthetic materials could also be expected to be satisfactory but at this time have not been tried.

[0083] The pump 22 operates at approximately 1000 kPa whilst the feed gun 12 might operate between a minimum pressure of around 100 kPa (such as for light weight dry particulates such as insulation compounds) and a maximum pressure of around 600 kPa (such as for heavy or dense castables). It is the differential in pressure between these two units which allows for the liquid ejected from the nozzle 20.8 to enter into the stream of the dry particulate material from the feed gun 12.

[0084] As is illustrated in figure 10, there are some height and distance limitations to the above described system, based on a feed hose diameter of 38mm and a mixing device 20 for use there with.

[0085] In the table below is a summary of the expected limitations:

| Location of Gun, Mixer, Nozzle (Height in metres) | Distance from Gun to Mixer (Conduit distance in metres) | Distance from Mixer to Nozzle (Conduit distance in metres) |
|--|--|---|
| All at same level (to within 1 to 2 metres) | 90 | 20 to 40 |
| Mixer 10 metres above Gun | 30 | 20 to 40 |
| Mixer 20 metres above Gun | 30 | 20 |

[0086] It is desirable to ensure that the minimum distance from the mixing device 20 to the nozzle 17 is, in most applications, no less than 20 metres. This distance allows dwell time of the product preform to be at its most desirable. Likewise, a distance greater than 40 metres may make the dwell time too great. These dimensions are of course dependent upon whether setting accelerators or inhibitors are utilised.

[0087] While the above description and mixing device 20 is exemplified relative to 38mm diameter feed hoses, the mixing device 20 having the dimensions discussed above will be suitable for 20mm and 32mm standard size hoses as well. However, to increase to a standard size hose of 50mm, 55mm or 65mm, a mixing device 20 having generally larger dimensions will be required for effective operation thereof.

[0088] It will be understood that the invention disclosed and defined herein extends to all alternative combinations of two or more of the individual features mentioned or evident from the text. All of these different combinations constitute various alternative aspects of the invention.

[0089] The foregoing describes embodiments of the present invention and modifications, obvious to those skilled in the art can be made thereto, without departing from the scope of the present invention.

Dated this 5th Day of April 2004
Shinagawa Refractories Australasia Pty Ltd
By its patent attorneys
Halford & Co

CLAIMS:

1. A slurry spraying or installation system including a gun means, a spray nozzle and a conduit connecting said gun means to said spray nozzle, said gun means including a pump means to move dry particulate towards said nozzle along said conduit, wherein between said gun means and said nozzle is a mixing device which receives said dry particulate and mixes same with liquid under a greater pressure than the pressure that said dry particulate is under, so as to form a liquid and dry particulate mixture; said mixture being fed to said nozzle for dispensing to a target.
2. A system as claimed in claim 1, wherein said mixing device includes an expansion chamber having a diverging passage which diverges in the direction of flow of said dry particulate.
3. A system as claimed in claim 2, wherein said mixing device includes, downstream of said diverging passage, a transition passage which has a substantially constant cross section.
4. A system as claimed in claim 3, wherein at least one of said diverging passage or said transition passage, or between these passages, there is included a liquid inlet.
5. A system as claimed in claim 4, wherein said liquid inlet includes a liquid inlet nozzle which projects liquid at an angle to the direction of flow of said dry particulate through said mixing device.
6. A system as claimed in claim 4, wherein said liquid inlet nozzle can be at an angle of between 40° and 80° from the direction of flow.
7. A system as claimed in claim 5 or 6, wherein said nozzle is aligned so that a central longitudinal axis thereof intersects a central longitudinal axis of said mixing device.
8. A system as claimed in claim 5 or 6, wherein said nozzle is aligned so that a central longitudinal axis thereof is skewed relative to a central longitudinal axis of said mixing device.
9. A system as claimed in any one of the preceding claims where said mixing device includes a converging passage downstream of said transition passage.
10. A system as claimed in any one of the preceding claims, wherein an inlet to the diverging passage is of a larger cross sectional area than the cross sectional area of the end of a conduit delivering said dry particulate from said gun means to said mixing device.

11. A system as claimed in any one of claims 1 to 10, wherein said inlet to the diverging passage has a diameter in the range from 5% to 200% larger than the internal diameter of a conduit delivering dry particulate to said diverging passage.
12. A system as claimed in claim 10 or 11, wherein said conduit has an internal diameter of approximately 38mm and said inlet diameter of said diverging passage is in the range of 40 to 60mm and possibly up to 80mm.
13. A system as claimed in any one of the preceding claims, wherein the inside diameter of said diverging passage at the end of said passage is of the order of 55 mm to 80 mm.
14. A system as claimed in any one of the preceding claims, wherein a preferred set of dimensions for the diverging passage includes: the inlet is 50mm and the end of the passage expands out to 65mm for a 38mm inside diameter conduit delivering dry particulate to said diverging passage.
15. A system as claimed in any one of the preceding claims, wherein said diverging passage can be of a length which varies from 150mm to 900mm.
16. A system as claimed in any one of the preceding claims, wherein said transition passage can have the same cross sectional area or internal diameter as the outlet end of the diverging passage.
17. A system as claimed in claim 16, wherein said transition passage extends for a distance of between 100mm and 300mm.
18. A system as claimed in any one of the preceding claims, wherein said converging passage terminates in an outlet passage of substantially constant cross section.
19. A system as claimed in claim 18, wherein said outlet has a cross sectional area which is approximately equal to the cross sectional area of the passage in a conduit to be connected to said outlet.
20. A system as claimed in claim 18 or 19, wherein said converging passage has its largest diameter in the order of 60mm to 80mm and it tapers down to 38mm at its outlet diameter.
21. A system as claimed in claim 20, wherein the length of the taper can vary between 350mm and 1500mm, but preferably between 600mm to 800mm and most preferably around 720mm.
22. A system as claimed in claim 18, wherein said outlet passage which is of substantially constant cross section can extend for between 80mm and 200mm and more preferably 120mm.

23. A system as claimed in any one of the preceding claims, wherein the liquid inlet can be a liquid ring.
24. A system as claimed in any one of the preceding claims, wherein when the gun means, the nozzle during use, and the mixing device are within a height differential of between up to 1 metre to 2 metres of each other, the mixing device is located along a conduit length of no more than 90 metres from the nozzle.
25. A system as claimed in any one of the preceding claims, wherein said mixing device is in the range of 5 m to 15 m of conduit length from the gun means.
26. A system as claimed in any one of the preceding claims, wherein said gun means preferably applies a pressure of between 100kpa and 600kpa to the dry particulate.
27. A system as claimed in any one of the preceding claims, wherein said liquid inlet to the mixing device has its own supply and pressure source.
28. A system as claimed in claim 27, wherein said pressure source can supply liquid to the liquid inlet at approximately 1000kpa.
29. A system as claimed in claim 27, wherein the pressure source can supply enough pressure to provide a pressure differential between the liquid inlet pressure and the dry particulate pressure of the order of 200kpa to 900kpa.
30. A system as claimed in any one of the preceding claims, wherein the liquid inlet nozzle propels liquid in a spray having a spray angle in the order of 70° to 120° with a flow rate of between 1 US gallon per minute to 4 US gallons per minute.
31. A system as claimed in any one of the preceding claims, wherein the system develops a pressure of the order of 100kPa to 200kPa, when measured in the conduit feeding the nozzle, at a location approximately 1 metre to 2 metres back from the nozzle.
32. A system as claimed in any one of the preceding claims, wherein said system includes the ability to add liquid to the preform slurry at said nozzle prior to ejection or emission from said nozzle.
33. A mixing device to preform a settable slurry, said device including an inlet having a larger internal cross sectional area than a hose connected to said device to deliver to said device a dry particulate under pressure to be preformed into said slurry, a diverging passage extending from said inlet and a transition passage located downstream of said diverging passage, said

transition passage having a substantially constant cross section, and a liquid inlet being located in one said diverging passage or said transition passage.

34. A mixing device as claimed in claim 33, wherein said mixing device is formed from liners which respectively include the diverging transition and converging passages.
35. A mixing device as claimed in any one of claims 33 or 34, wherein said inlet end of the diverging passage has a flange to allow said inlet end to connect to a hose by a coupling device.
36. A mixing device as claimed in any one of claims 33 to 35, wherein there is included a converging passage whereby the outlet end of the converging passage has a flange to allow connection to a conduit by a coupling device.
37. A mixing device as claimed in any one of claims 33 to 36, including one or more of the features described above which are attributable to a mixing device as described in claims 1 to 32.

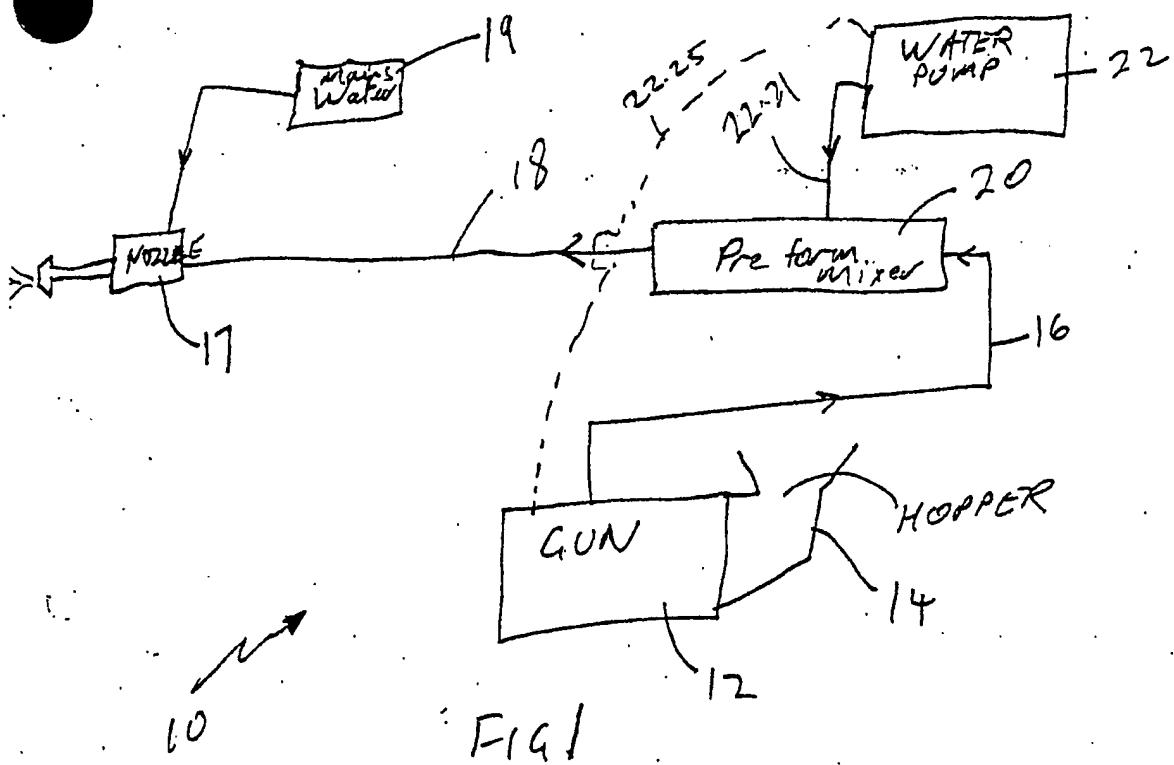


FIG 1

FIG 4

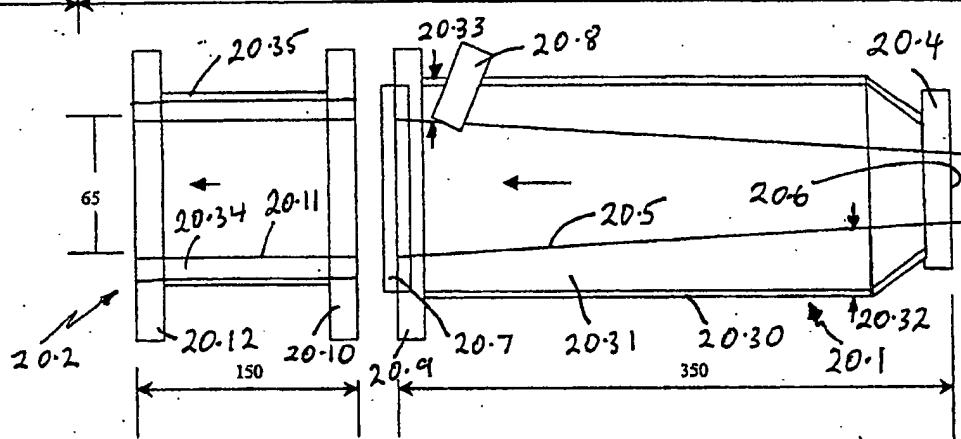
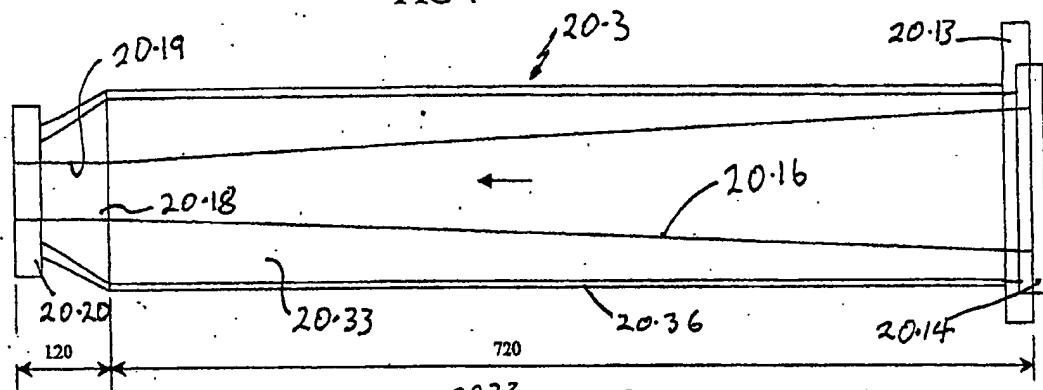


FIG 3

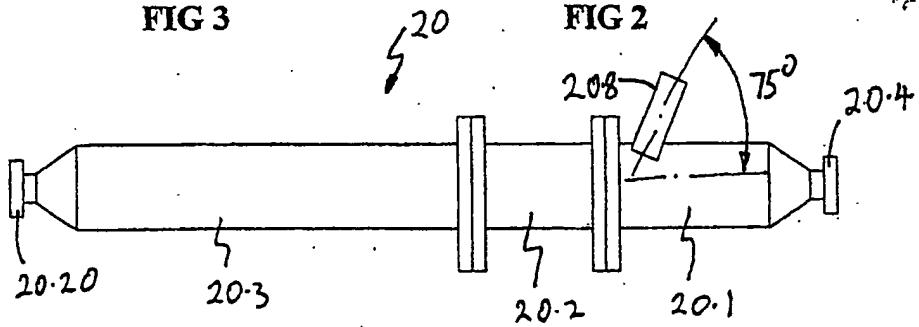
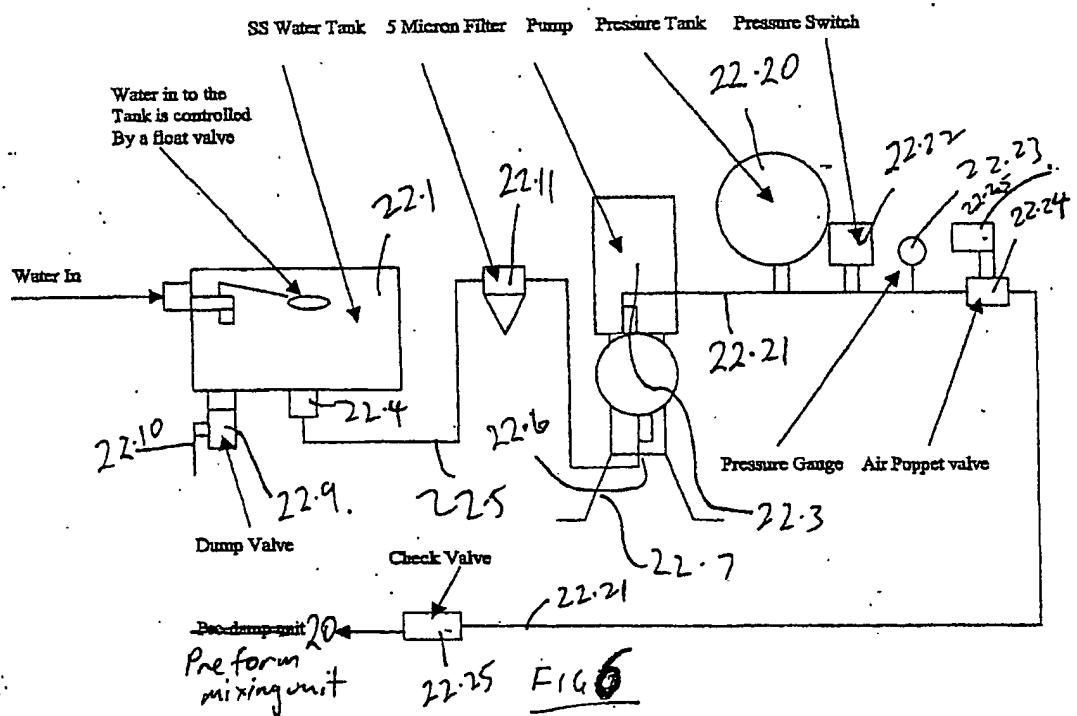


FIG 5



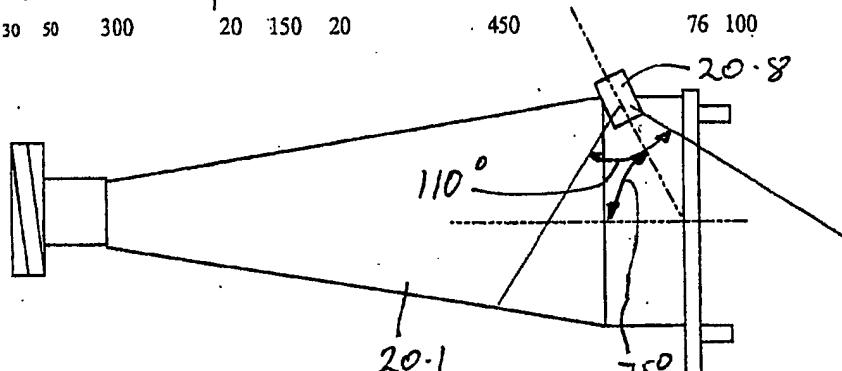
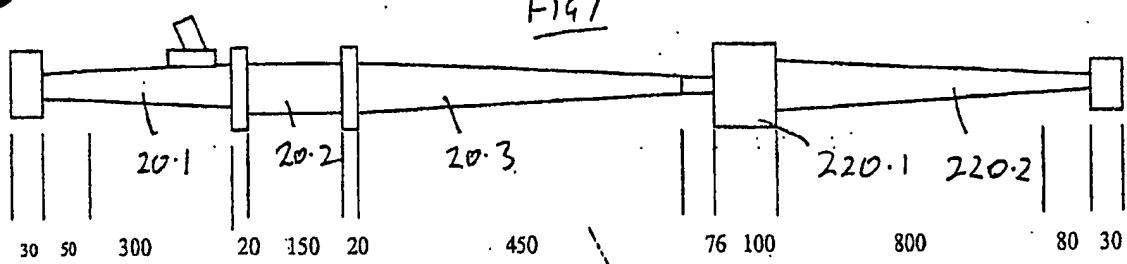


FIG 8

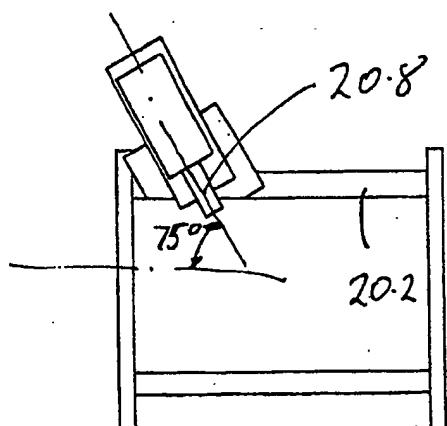


FIG 9

30 Meters level

Maximum Elevation for Dense low cement castable 30 Meters dry

Feed Hose.



Maximum Elevation for Dense low cement castable with the unit 10 Meters

20 Meter level dry only or move unit to this level then run 20 to 40 Meters with less than 10 Meters of elevation over the length

10 Meter level dry or with unit in the line

With the unit in place 90 meters is the recommended maximum conveyancing distance at zero elevation

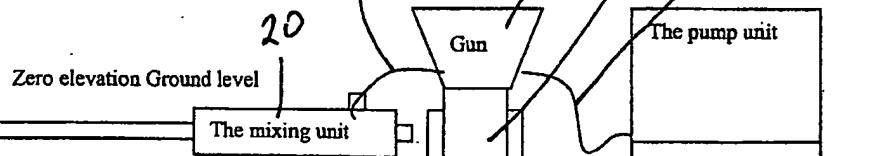


FIG 10

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Flat Spray Standard Nozzles

Ordering Number: BH1/4VV-SS8003
Description: VeeJet Spray Nozzles, Standard Spray, Small Capacity



Image is representative only, actual part may vary.

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Cooling and quenching, Product washing, Water cooling, Air and gas washers, Scrubbers, Liquor washers, Dust control, Fire protection

Standard VeeJet spray nozzles feature a high impact solid stream or flat spray pattern with spray angles of 0° to 110° at 40 psi (3 bar). They produce a uniform distribution of small-to medium-sized drops. Specially tapered spray pattern edges provide even spray coverage when several nozzles with over-lapping patterns are required. Model H-VV VeeJet nozzles feature flow rates below 1 gpm at 40 psi (3.9 l/min at 3 bar).

| | |
|--|---|
| Nozzle Inlet Connection | Male BSPT |
| Spray Angle @ 40 psi (degrees) | 80 |
| Spray Pattern Type @ 40 psi (degrees) | Tapered Edge |
| Capacity (gallons per minute) @ 40 psi | 0.3 |
| Nozzle Type | H-VV |
| Inlet Connection (inches) | 1/4 |
| Capacity Size | 03 |
| Material | 303 Stainless Steel |
| Material Code | SS |
| Length (inches) | 29/32 |
| Hex (inches) | 9/16 |
| Net Weight (oz) | 3/4 |
| Option | Integral Strainer |
| Minimum PSI | 5 |
| Maximum PSI | 500 |
| Accessories | Split-eyelet Connector, Pressure Gauges, Adjustable Ball Fittings, Pressure Relief Valves, Strainers, Control Valves, Check Valves, Swivel Connectors |

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FIG 11

http://www.ispray.com/sc_app/sc_specsheets.asp?famID=2010&vid=0,0,0,0&prtNo=BH1/4VV-SS8003&... 03-Apr

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Flat Spray Standard Nozzles

Ordering Number: BH1/4VV-SS11003
Description: VeeJet Spray Nozzles, Standard Spray, Small Capacity



Image is representative only, actual part may vary.

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Specifications

| | |
|--|---|
| Nozzle Inlet Connection | Male BSPT |
| Spray Angle @ 40 psi (degrees) | 110 |
| Spray Pattern Type @ 40 psi (degrees) | Tapered Edge |
| Capacity (gallons per minute) @ 40 psi | 0.3 |
| Nozzle Type | H-VV |
| Inlet Connection (inches) | 1/4 |
| Capacity Size | 03 |
| Material | 303 Stainless Steel |
| Material Code | SS |
| Length (inches) | 29/32 |
| Hex (inches) | 9/16 |
| Net Weight (oz) | 3/4 |
| Option | Integral Strainer |
| Minimum PSI | 5 |
| Maximum PSI | 500 |
| Accessories | Split-eyelet Connector, Pressure Gauges, Adjustable Ball Fittings, Pressure Relief Valves, Strainers, Control Valves, Check Valves Swivel Connectors |

Standard Applications

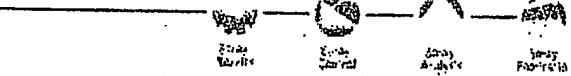
Cooling and quenching, Product washing, Water cooling, Air and gas washers, Scrubbers, Liquor washers, Dust control, Fire protection

Design Features

Standard VeeJet spray nozzles feature a high impact solid stream or flat spray pattern with spray angles of 0° to 110° at 40 psi (3 bar). They produce a uniform distribution of small-to medium-sized drops. Specially tapered spray pattern edges provide even spray coverage when several nozzles with over-lapping patterns are required. Model H-VV VeeJet nozzles feature flow rates below 1 gpm at 40 psi (3.9 l/min at 3 bar).

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FIG 12

http://www.ispray.com/sc_app/sc_specsheets.asp?famID=2010&vid=0,0,0,0&prtNo=BH1/4VV-SS11003... 03-Ap

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Flat Spray Standard Nozzles

Ordering Number: BH1/4VV-SS110015
Description: VeeJet Spray Nozzles, Standard Spray, Small Capacity



Image is representative only, actual part may vary.

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Specifications

| | |
|--|---------------------|
| Nozzle Inlet Connection | Male BSPT |
| Spray Angle @ 40 psi (degrees) | 110 |
| Spray Pattern Type @ 40 psi (degrees) | Tapered Edge |
| Capacity (gallons per minute) @ 40 psi | 0.15 |
| Nozzle Type | H-VV |
| Inlet Connection (inches) | 1/4 |
| Capacity Size | 015 |
| Material | 303 Stainless Steel |
| Material Code | SS |
| Length (inches) | 29/32 |
| Hex (inches) | 9/16 |
| Net Weight (oz) | 3/4 |
| Option | Integral Strainer |
| Minimum PSI | 5 |
| Maximum PSI | 500 |

Accessories

Split-eyelet
 Connector, Pressure
 Gauges, Adjustable
 Ball Fittings, Pressure
 Relief Valves,
 Strainers, Control
 Valves, Check Valves
 Swivel Connectors

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ISO 9001
 13022

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FIG 13

http://www.ispray.com/sc_app/sc_specsheets.asp?famID=2010&vid=0,0,0,0&prtNo=BH1/4VV-SS11001... 03-Af

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PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY
(Chapter I of the Patent Cooperation Treaty)

(PCT Rule 44bis)

| | | | |
|--|---|---|------------------|
| Applicant's or agent's file reference ROC05048 | FOR FURTHER ACTION | | See item 4 below |
| International application No. PCT/AU2005/000470 | International filing date (<i>day/month/year</i>) 31 March 2005 (31.03.2005) | Priority date (<i>day/month/year</i>) 05 April 2004 (05.04.2004) | |
| International Patent Classification (8th edition unless older edition indicated) See relevant information in Form PCT/ISA/237 | | | |
| Applicant SHINAGAWA REFRACTORIES AUSTRALASIA PTY LTD | | | |

1. This international preliminary report on patentability (Chapter I) is issued by the International Bureau on behalf of the International Searching Authority under Rule 44 bis.1(a).

2. This REPORT consists of a total of 6 sheets, including this cover sheet.

In the attached sheets, any reference to the written opinion of the International Searching Authority should be read as a reference to the international preliminary report on patentability (Chapter I) instead.

3. This report contains indications relating to the following items:

| | |
|--|---|
| <input checked="" type="checkbox"/> Box No. I | Basis of the report |
| <input type="checkbox"/> Box No. II | Priority |
| <input type="checkbox"/> Box No. III | Non-establishment of opinion with regard to novelty, inventive step and industrial applicability |
| <input checked="" type="checkbox"/> Box No. IV | Lack of unity of invention |
| <input checked="" type="checkbox"/> Box No. V | Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement |
| <input type="checkbox"/> Box No. VI | Certain documents cited |
| <input type="checkbox"/> Box No. VII | Certain defects in the international application |
| <input checked="" type="checkbox"/> Box No. VIII | Certain observations on the international application |

4. The International Bureau will communicate this report to designated Offices in accordance with Rules 44bis.3(c) and 93bis.1 but not, except where the applicant makes an express request under Article 23(2), before the expiration of 30 months from the priority date (Rule 44bis .2).

| |
|---|
| Date of issuance of this report 11 October 2006 (11.10.2006) |
|---|

| | |
|---|---|
| The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No. +41 22 338 82 70 | Authorized officer Dorothée Mülhausen e-mail: pt01@wipo.int |
|---|---|

PATENT COOPERATION TREATY

From the:
INTERNATIONAL SEARCHING AUTHORITY

REC'D 14 JUN 2005

WIPO PCT

To:

Halford & Co.
No 1 Market Street
SYDNEY NSW 2000

PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43bis.1)

| | | | |
|---|---|--|------------|
| | | Date of mailing (day/month/year) | 8 JUN 2005 |
| Applicant's or agent's file reference C05048 | | FOR FURTHER ACTION See paragraph 2 below | |
| International application No. PCT/AU2005/000470 | International filing date (day/month/year) 31 March 2005 | Priority date (day/month/year) 5 April 2004 | |
| International Patent Classification (IPC) or both national classification and IPC Int. Cl. 7 F27D 1/16, B28C 7/16, B05B 7/14 | | | |
| Applicant SHINAGAWA REFRactories AUSTRALASIA PTY LTD et al | | | |

1. This opinion contains indications relating to the following items:

- Box No. I Basis of the opinion
- Box No. II Priority
- Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- Box No. IV Lack of unity of invention
- Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- Box No. VI Certain documents cited
- Box No. VII Certain defects in the international application
- Box No. VIII Certain observations on the international application

2. FURTHER ACTION

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1bis(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

3. For further details, see notes to Form PCT/ISA/220.

| | |
|---|--|
| Name and mailing address of the IPEA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaaustralia.gov.au Facsimile No. (02) 6285 3929 | Authorized Officer A DAVIES Telephone No. (02) 6283 2072 |
|---|--|

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

International application No.

PCT/AU2005/000470

Box No. I

Basis of the opinion

1. With regard to the language, this opinion has been established on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

This opinion has been established on the basis of a translation from the original language into the following language , which is the language of a translation furnished for the purposes of international search (under Rules 12.3 and 23.1(b)).

2. With regard to any nucleotide and/or amino acid sequence disclosed in the international application and necessary to the claimed invention, this opinion has been established on the basis of:

a. type of material

a sequence listing
 table(s) related to the sequence listing

b. format of material

in written format
 in computer readable form

c. time of filing/furnishing

contained in the international application as filed.
 filed together with the international application in computer readable form.
 furnished subsequently to this Authority for the purposes of search.

3. In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

4. Additional comments:

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

International application No.

PCT/AU2005/000470

Box No. IV Lack of unity of invention

1. In response to the invitation (Form PCT/ISA/206) to pay additional fees the applicant has:
 - paid additional fees
 - paid additional fees under protest
 - not paid additional fees
2. This Authority found that the requirement of unity of invention is not complied with and chose not to invite the applicant to pay additional fees.
3. This Authority considers that the requirement of unity of invention in accordance with Rule 13.1, 13.2 and 13.3 is
 - complied with
 - not complied with for the following reasons:

1. Claims 1-34 are directed to a slurry spraying system which includes a gun means, a spray nozzle and a conduit connecting said gun means to said spray nozzle, said gun means including a pump means to move dry particulate towards said nozzle along said conduit with a mixing device between said gun means and said nozzle. It is considered that the "slurry spraying system which includes gun means, a spray nozzle and a conduit connecting said gun means to said spray nozzle, said gun means including a pump means to move dry particulate towards said nozzle along said conduit with a mixing device between said gun means and said nozzle" constitutes a first special technical feature

2. Claims 35-40 are directed to a mixing device having an inlet having a larger internal cross section than a hose connected to the mixing device, a diverging passage extending from said inlet and a transition passage located downstream of said diverging passage said transition passage having a substantially constant cross section and a liquid inlet being located in the diverging passage or said transition passage. It is considered that the "inlet having a larger internal cross section than a hose connected to the mixing device, a diverging passage extending from said inlet and a transition passage located downstream of said diverging passage said transition passage having a substantially constant cross section and a liquid inlet being located in the diverging passage or said transition passage" constitutes a second special technical feature.

Since the abovementioned groups of claims do not share either of the special technical features identified, a "technical relationship" between the inventions, as defined in PCT rule 13.2 does not exist. Accordingly the international application does not relate to one invention or to a single inventive concept.

4. Consequently, this opinion has been established in respect of the following parts of the international application:

- all parts
- the parts relating to claims Nos. 1-34

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

International application No.

PCT/AU2005/000470

Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

| | | |
|-------------------------------|--------------------|-----|
| Novelty (N) | Claims 2-24, 26-34 | YES |
| | Claims 1,25 | NO |
| Inventive step (IS) | Claims 2-24, 26-34 | YES |
| | Claims 1,25 | NO |
| Industrial applicability (IA) | Claims 1-34 | YES |
| | Claims | NO |

2. Citations and explanations:

US, 2124989

US, 3881688

US, 4272020

GB, 2025794

EP, 0405969

All the above citations are within the field of concrete or refractory spraying and disclose the pneumatic conveying of dry particulate matter to a mixing device in which liquid (clearly at a pressure greater than that of the dry particulate stream – or no appropriate mixing would occur), is injected and the resulting slurry is dispensed toward a target. In these citations the liquid inlet is in the form of an annular ring surrounding the mixing device.

As a result claims 1 and 25 of the application are not novel and uninventive.

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

International application No.

PCT/AU2005/000470

Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

Claims 11,13,14-16, 20 and 32 are incorrectly appended to claim 1. Claim 11 for example is appended to claim 1 and it talks about "the diverging passage". Claim 1 is wholly silent as to this diverging passage.

Similar considerations apply to the "converging passage" and the "liquid inlet nozzle". None of these can be found in claim 1 yet the claims containing these items are claimed "in any one of the preceding claims".